SIGHTING ANALYSIS AND PHOTO-IDENTIFICATION OF HUMPBACK WHALES, OFF WESTERN AUSTRALIA, 1989

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During 1989, 492 humpback whales *Megaptera novaeangliae* of the Southern Hemisphere Group IV stock were observed off the Western Australian coast, and 118 of these were photographically identified using tail fluke and lateral body pigmentation patterns. Most observations were made during whale-watching cruises conducted off Perth, with the highest sighting rates (whales/sighting hour) being recorded in September and October. Sightings of mother-calf pairs increased in November. To improve efficiency of identification, animals were classified into 4 Types according to the proportions of white and black pigment on the lateral body and the ventral side of the tail flukes. The degree of coverage of yellow colouration on the tail flukes, presumably caused by the diatom *Cocconeis*, was classified using the same proportional method. □Humpback Whale, *Megaptera novaeangliae*, pigmentation, photo-identification, sighting, Western Australia.

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Humpback whales (*Megaptera novaeangliae*) which migrate along the Western Australian coast, comprise the Southern Hemisphere Group IV stock that was severely depleted by commercial whaling from an estimated 12,000–17,000 animals to c. 800 by 1962 (Chittleborough, 1965). Recent aerial surveys show that the stock has been increasing, having at least doubled between 1963 and 1982, and having continued to increase since then (Bannister, this memoir). On that basis the stock may now be more than 2000 animals.

Tail fluke photography is a valid means for humpback whale identification (Katona, 1979; Glockner & Venus, 1983; Baker et al., 1986; Stone, Katona & Tucker, 1987). Photographing the lateral body pigmentation patterns in addition to flukes increases the number of individually identified whales (Kaufman, Smultea & Forestell, 1987).

Photographic identification of individuals will assist in analysis of migration patterns, distribution and stock identity of this population of humpback whales. Whale watching tours provide an opportunity to photograph many individuals and collect abundance and pod composition data over a short time span within a specific area.

Watching humpback whales has become a viable industry on the east coast of Australia, where much research has been conducted into identification and monitoring of the Area V population (Bryden & Slade, 1987; Bryden, Corkeron & Slade, 1988; Kaufman, Smultea & Forestell, 1987; Paterson & Paterson, 1989).

In Hawaii, observations from consecutive years of commercial whale watching have been used to investigate changes in humpback pods and calf encounters (Salden,1988). In Perth, whalewatching tours by Underwater World from Hillary's Boat Harbour provided a valuable platform for research on humpback whales. This paper presents in two parts, results from analysis of photographs obtained during 1989 and from data collected during the whale watching cruises.

PART 1 - PHOTO-IDENTIFICATION

Methods

During July and August 1989, humpback whales were photographed in Shark Bay from a 5.3m runabout, and off North West Cape from a professional fishing boat. From September to November 1989, photographs were taken during whale watching and from a 5.4m runabout. Locations of all sampling areas are shown in Fig. 1.

A 35mm SLR camera with a 35–200mm zoom lens was used for all photographs. The larger tour operators' vessels operators came no

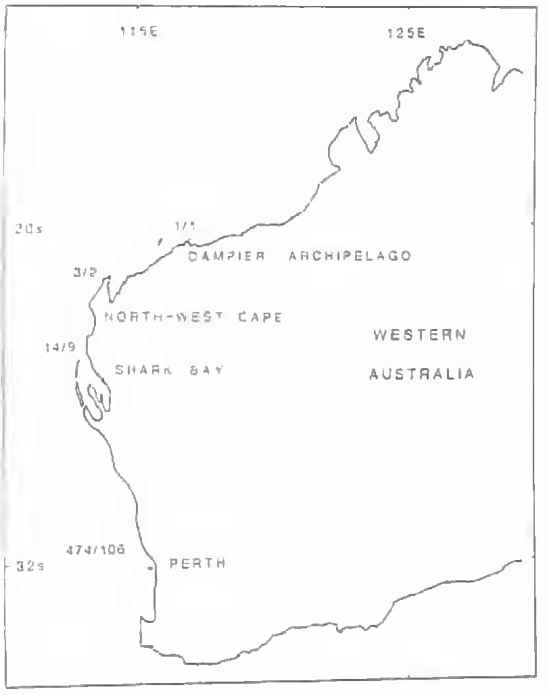

FIG. 1. Humpback whale observations and photographs, 1989. (observations/photo-ids).

closer to the whales than 50m. Interference to the pods was minimised, and often good photographs were obtained when whales themselves became the curious observers.

Data collected included details of pod structure, behaviour, time and photographs. Adults were presumed to be female only if in close association with a calf. Differentiation between adults and subadults was not made. The number of whales observed daily was recorded, as not all whales could be photographed. Copies of the photographs were sent to the Western Australian Museum and to the Pacific Whale Foundation for use in compiling catalogues.

Classification of the lateral colouration of individuals follows that described by Kaufmann et al. (1987) (Fig. 2) using the proportion of white pigmentation on the lateral body, with Type 1 having the greatest and Type 4 the least (Fig.3). Whales which did not present sufficient lateral body when surfacing to accurately classify were classified as undetermined.

Colouration of the ventral sides of the tail flukes was also assessed, using a similar proportional method to the lateral colouration, with Type 1 mostly white and Type 4 mostly black. The flukes were divided by a straight line from

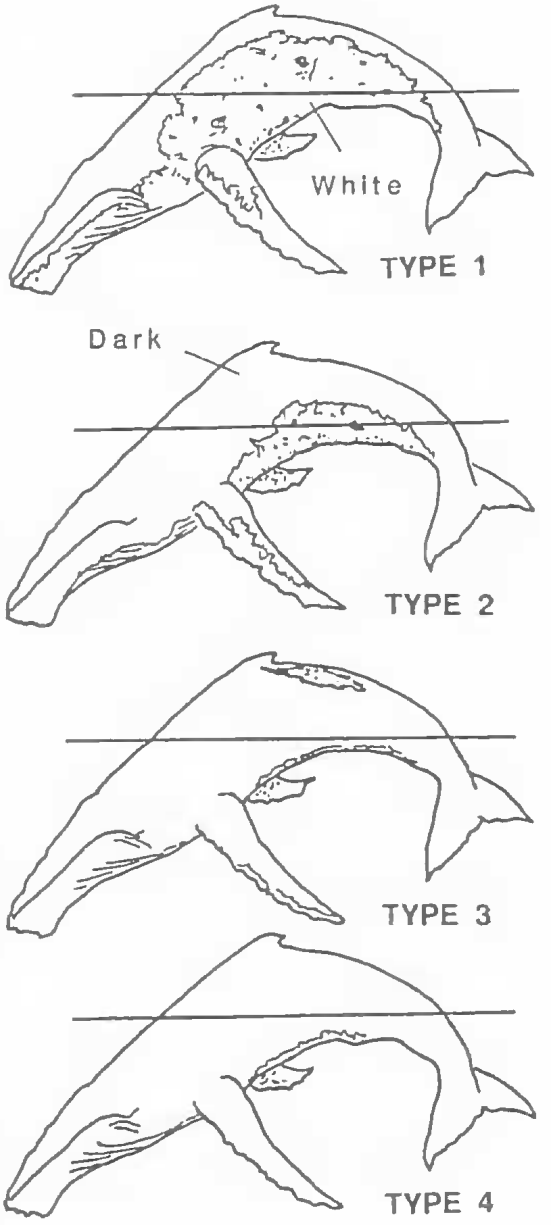

FIG. 2. Lateral body pigmentation types displayed by Australian Humpback Whales. Illustrations by Lili Hagen. courtesy of G. Kaufman, Pacific Whale Foundation. TYPE 1, White coloration reaches above the horizontal mid-line of the body, generally extending anterior to dorsal fin. TYPE 2, White coloration extending to body midline or above, with coloration generally observed near the caudal peduncle.TYPE 3, An obvious but less distinct whitish-grey coloration patch along the dorsal surface of the caudal peduncle posterior to the dorsal fin. TYPE 4, Lack of obvious white pigmentation patterns.

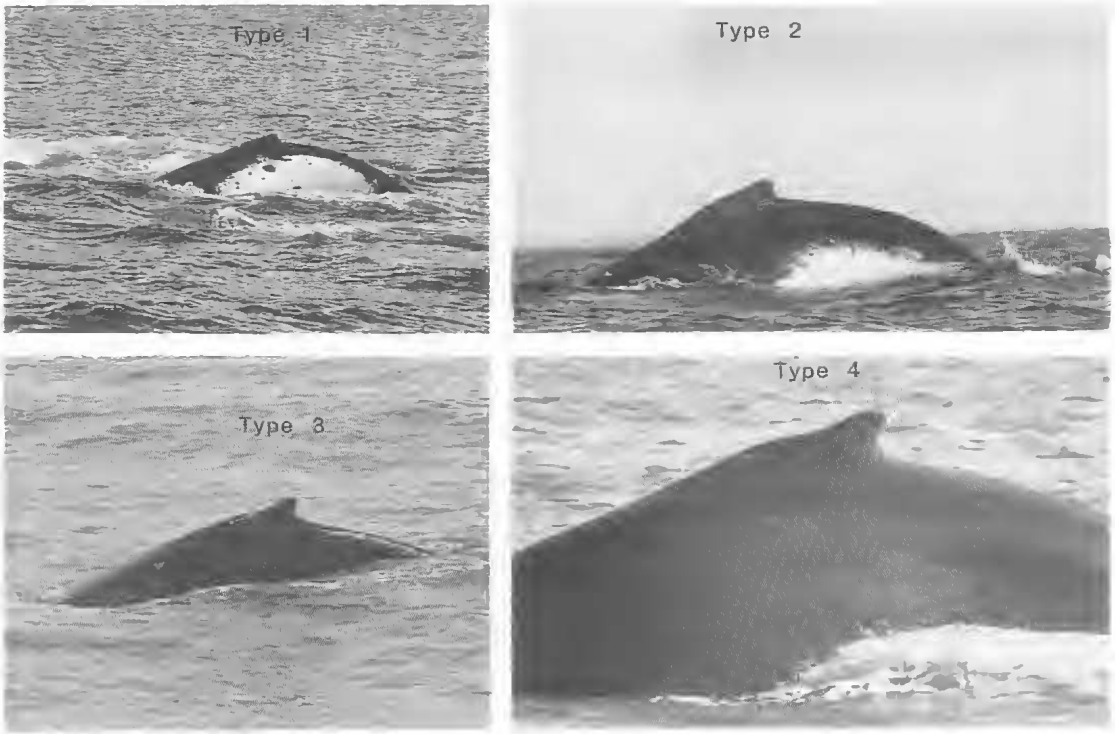

FIG. 3. Identified Humpback Whales from W.A., showing 4 lateral pigmentation types.

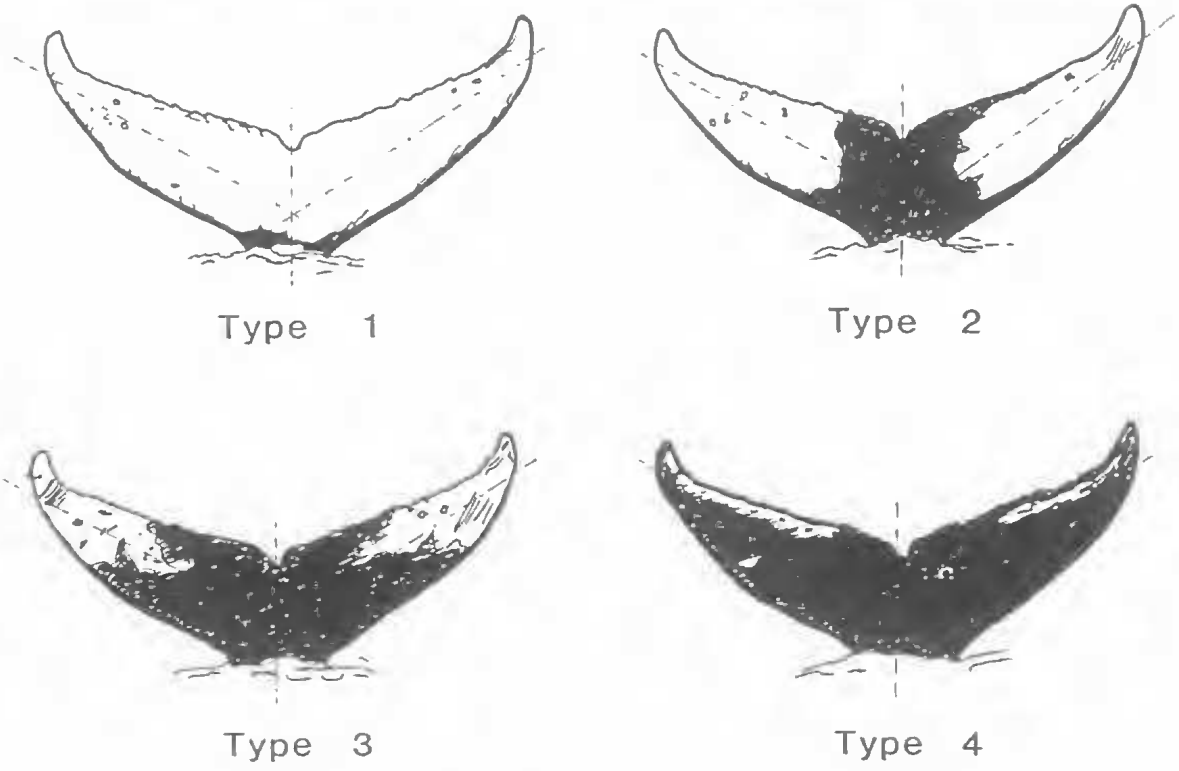

FIG. 4. Tail fluke pigmentation types of humpbacks off WA.

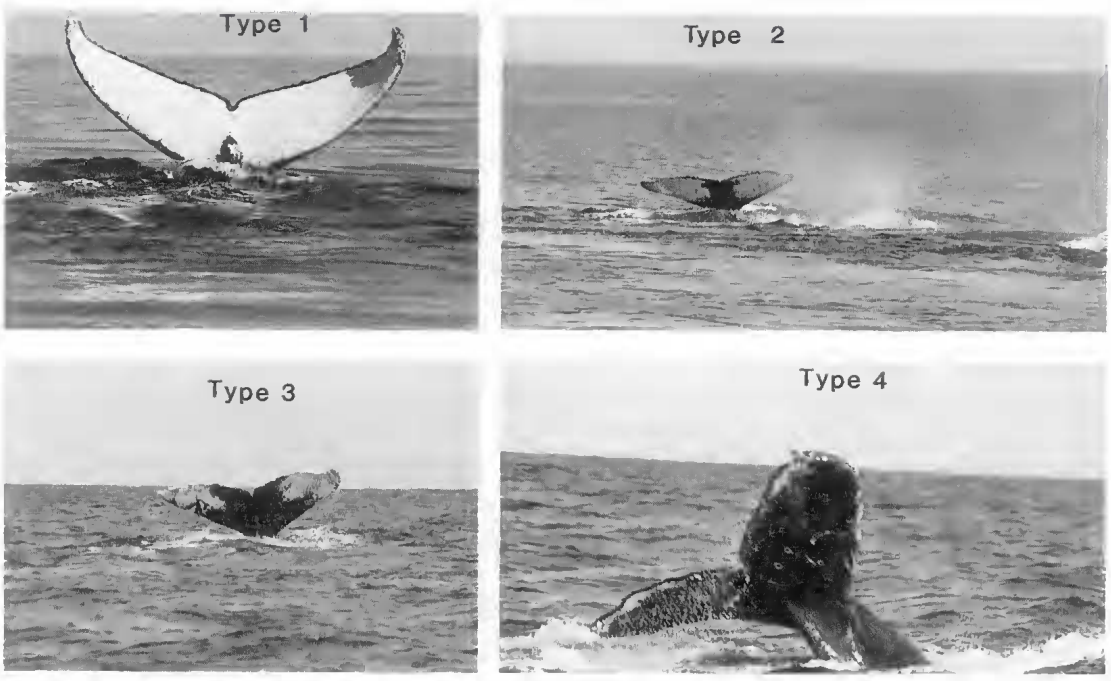

FIG. 5. Identified humpback whales from WA showing 4 tail fluke pigmentation types.

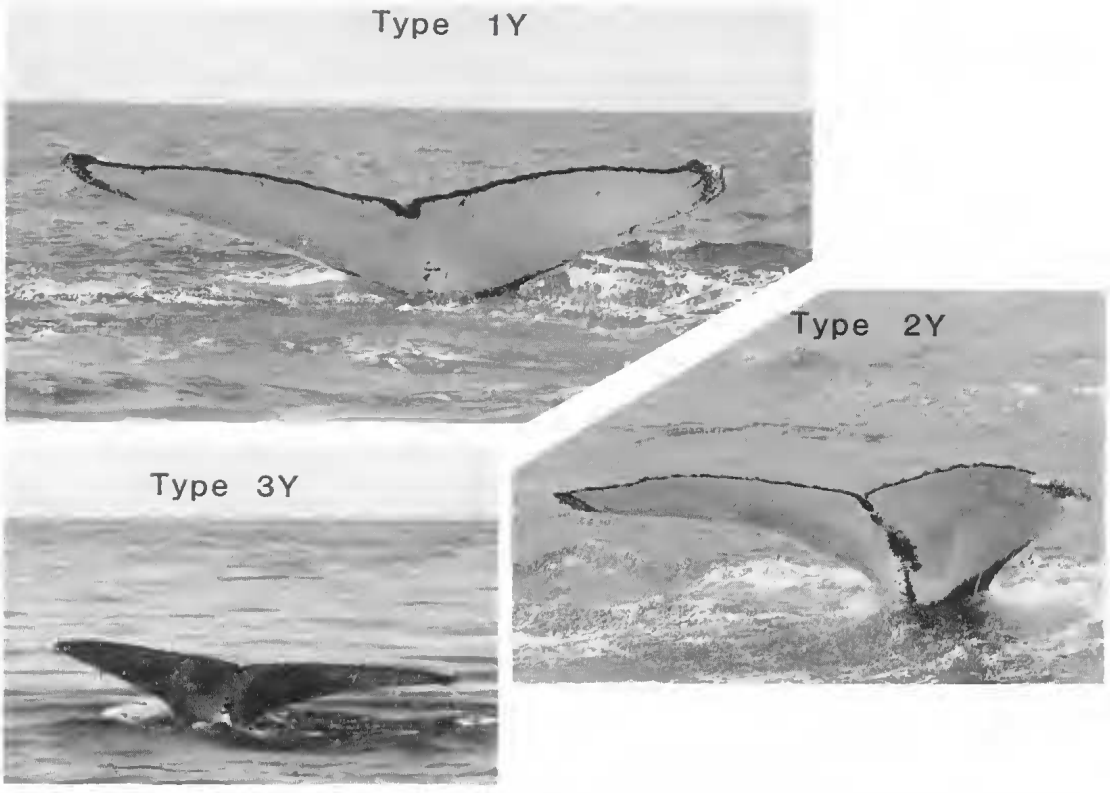

FIG. 6. Photographs of identified whales off WA, showing 3 of the 4 tail fluke diatom colouration categories (yellow).

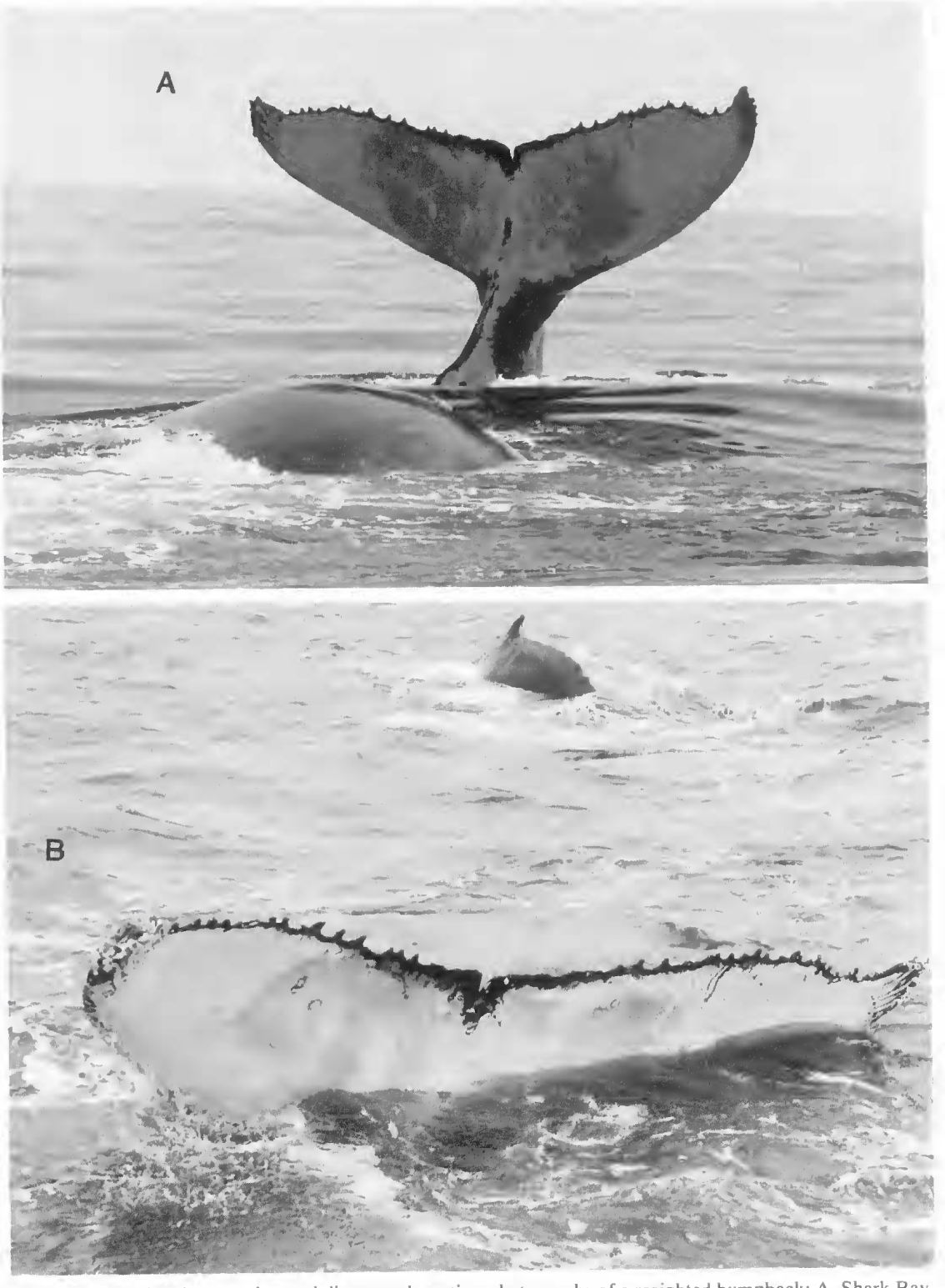

FIG. 7. Tail fluke pigmentation and diatom colouration photographs of a resighted humpback; A, Shark Bay, 12 July, 1989. B, Perth, 27 and 30 September, 1989.

the fluke tip to the centre of the median strip between each fluke to assist in determining Type 2 and Type 3 animals (Fig. 4). A Type 2 fluke is categorised as having <50% black pigmentation and a Type 3 fluke having >50% black (Fig.5).

Many identified animals had some yellow colouration on the underside of the flukes, presumably due to a film of the Antarctic diatom *Cocconeis ceticola*. The typically yellowish colour of this species on the skin of whales in warmer waters of the Southern Hemisphere has been taken to indicate movement of the whale from colder waters (Bannister, 1977).The degree of diatom coverage on the underside of the tail flukes was assessed using the proportional method described above for the white/black pigmentation patterns, with Type 1 having little yellow and Type 4 being mostly yellow. Types 2 and 3 animals have < and >50% yellow colouration, respectively (Fig.6). Tail flukes of animals which were too distant and had uneven lighting, or which were at too low an angle to accurately see the black and white or yellow colouration, were classified as undetermined.

RESULTS

LOCATION	NO. OF WHALES	
	observed	photo-ID
Perth	474	106
Shark Bay	14	9
Northwest Cape	3	2
Dampier Archipelago	1	1
TOTAL	492	118

TABLE 1. Humpback whales off WA during 1989. Observations were made by the author except for the one off the Dampier Archipelago. 417 observations and 69 IDs were made during whale watching tours.

Class	Lateral body or fluke	Lateral body only	Fluke only	Total
Adult	13	40	50	103
Female	5	1	2	8
Calves	0	7	0	7
Total	18 (15.2%)	48 (40.7%)	52 (44.1%)	118

TABLE 2. Humpback whales identifed on lateral or fluke pigmentation patterns. Calves identified by lateral observation as none were observed fluking up.

LATERAL PIGMENTATION		
Category	No. of whales	% of types
Type 1 (mostly white	14	28%
Type 2 (<50% black)	9	18%
Type 3 (>50% black)	7	14%
Type 4 (mostly black)	20	40%
Undetermined	16	
Total	66	

TABLE 3.Classification of whales on degree of lateral pigmentation. Undetermined whales were identified by body marks, scars or dorsal fin characteristics.

FLUKE PIGMENTATION		
Category	No. of whales	% of types
Type 1 (mostly white)	50	75.8%
Type 2 (<50% black)	13	19.7%
Type 3 (>50% black)	3	4.5%
Type 4 (mostly black)	0	
Undetermined	4	
Total	70	

TABLE 4. Classification on degree of white and black pigmentation on the underside of the tail flukes.

DIATOM COLOURATION		
Category	No. of whales	% of types
Type 1 (mostly white)	15	36.6%
Type 2 (<50% yellow)	24	58.5%
Type 3 (>50% yellow)	2	4.9%
Type 4 (mostly yellow)	0	
Undetermined	29	
Total	70	

TABLE 5. Classification on degree of yellow colouration (diatoms) on the underside of tail flukes.

	DIATOM COLOURATION					
FLUKE COLOURATION	TYPES	1	2	3	4	Undet
	1	11	20	2		16
	2	3	4			6
	3	1				2
	4					
	Undet					5
	TOTAL	15	24	2		29

TABLE 6. The degree of diatom coverage according to fluke categorisation type.

One animal, identified in Shark Bay, was categorised as Type 2 yellow, and was still in that

category when resight ed off Perth 77 days later with very little change in diatom distribution on its tail flukes (Fig. 7).

INITIAL SIGHTING			RESIGHTING		
Location	Date	ID No.	Location	Date	Elapsed days
Shark B.	12.7.89	4	Perth	27.9.89	77
			Perth	30.9.89	4
Perth	9.11.89	100	Perth	15.11.89	7
Perth	9.11.89	101	Perth	15.11.89	7

TABLE 7. Resightings during 1989.

DISCUSSION

During the present study which focussed predominantly on the southern migration, 41% of animals were identified using only lateral and 44% using only fluke pigmentation patterns, compared to 25% and 17% of the animals of the Area V stock on the east coast (Kaufman *et al.*, 1987). Futhermore, a higher number of identified animals (58%) was obtained using either lateral or fluke patterns on the east coast compared to 15% on the west coast. This large difference may reflect the greater ease of manoeuvrability of smaller craft and the persistence of the researchers in obtaining both lateral and fluke photographs ie. a difference in methods. 1989 was the first year in which a concerted effort was made to identify many animals on the west coast.

Lateral Pigmentation

The 28% Type 1 and 40% Type 4 of my observations compare with 7% Type 1 and 37% Type 4 in eastern Australia (Kaufman *et al.*, 1987). From these initial data, it appears that the Group IV stock has a larger proportion of Type 1 animals.

Fluke Pigmentation

The 70% Type 1 and 95% Types 1+2 of my observations compare with 87% of flukes from 1984,85 animals of the Group V stock being 75% white (Kaufman et al., 1987). In the Northern Hemisphere nearly 62% of animals, including calves, had mostly black flukes (Glockner and Venus, 1983); their Types 4 and 5 equate to my Type 4. Although I identified no mostly black flukes, at least 2 were photographed by other people (G. Pobar, pers comm).

Categorising fluke patterns may help simplify resight analysis, as each ID can be placed in a type category rather than being checked against all other animals.

Diatom Coverage

Assessment of yellow colouration on specific whales which may be resighted after their northern migration may enable quantitative comparison over time of the change in diatom coverage. Colour photographs of flukes are better for assessment of diatom coverage than are black and white photographs. Of 41 individuals categorised, 95% had <50% diatom coverage whereas on the east coast there was little evidence of diatom coverage at all (M.Osmond, pers. comm). Difference in diatom coverage between Groups IV and V stocks may reflect geographical differences in the Southern Ocean feeding areas, but further comparisons are necessary before making any conclusions.

It is unclear how differences in diatom coverage relate to different fluke colourations. The extent to which diatom coverage may have been reduced by time spent in warm waters is unknown.

Resights

A mother-calf pair was sighted twice in 7 days in the same area off Perth, while another individual was resighted after 4 days. Many more whales are seen off Perth and south coastal areas from September to December than at other times. Certain population classes, for example, mother-calf pairs, may use the large bays and embayments off Western Australia (Shark Bay, Geographe Bay, Perth-Rottnest) for 'resting' areas during their southern migration. Photo-ID in Hawaii indicates residence times of up to 11 weeks (Darling,Gibson & Silber, 1983), and in Hervey Bay, Queensland, times of mainly 1 to 2 days, and up to 19 days (Bryden, Corkeron & Slade, 1988).

With the development of whale-watching as an industry off the coast of Perth, information on the distribution, behaviour, identification and ecology of whales will be essential, to properly understand and manage the interactions between people and whales.

PART 2 - SIGHTING ANALYSIS

Methods

Whale-watching tours are conducted from September to November during the southern

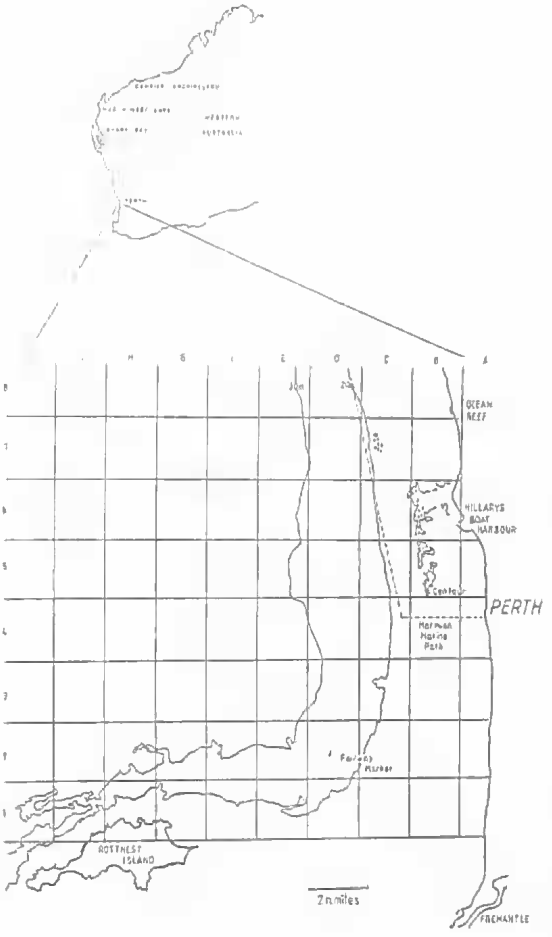

FIG. 8. The area of Indian Ocean between Perth and Rottnest Island where the whale watching tours were conducted during 1989.

migration of humpback whales which occurs between August and December.

AREA

The Indian Ocean, adjacent to Perth and north of Rottnest Island, was divided into grids of approximately 2 x 1.8 nautical miles to define sightings distribution (Fig 8). Tours were conducted west of the shallow limestone reefs which run parallel to the coast, and north of Rottnest Island, generally when wind speeds were below 15–20 knots.

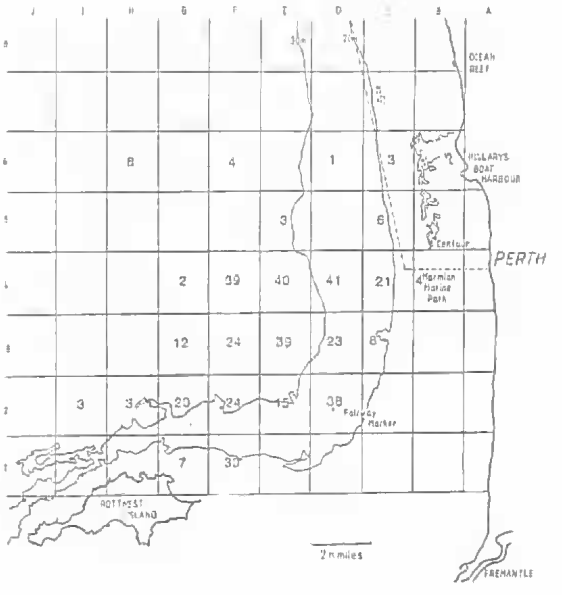

FIG. 9. Numbers of humpback whales (adults + calves)observed in each grid square during the southern migration.

VESSEL

Two vessels were used for the tours; a 15m aluminium monohull fishing vessel and a 10m fibreglass shark cat. The larger vessel had radar, and was used on most occasions. The vessels departed from the boat harbour at Hillary's and headed southwest towards Rottnest Island around the southern most Centaur Reef. At least 2 or 3 observers were continually looking for whales, and on most occasions the blow was the initial sighting cue.

DATA COLLECTION

Cruise description data gave starting and ending times and weather conditions during observation outside the fringing reefs. Locations of pods were specified by radar or compass bearings. A cruise path description was made on a grid as it was not possible to continuously plot each cruise using more accurate equipment. Sighting data consisted of individual whale counts, pod sizes, reproductive status, behaviour and photographs. Searching time included that spent with each pod and assumes that searching continues while with one pod. Searching time with the vessel moving would have been much

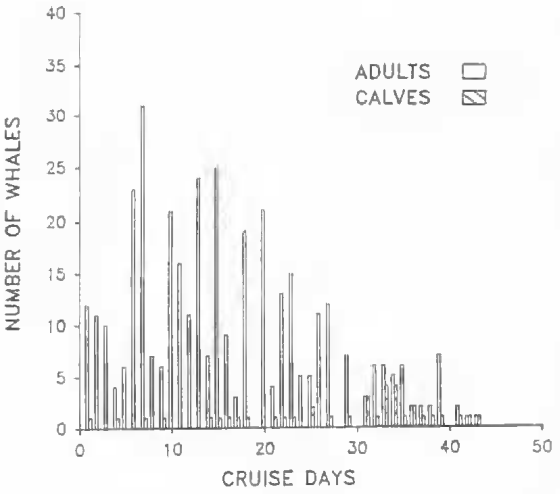

FIG. 10. Adults + calves sighted per day during the cruises, from September to December (southern migration), Perth, 1989.

less if time spent with each pod had not been included.

PHOTOGRAPHIC DOCUMENTATION

Efforts were concentrated in obtaining photos of the ventral side of the tail flukes and lateral views of each whale. Whales were inferred to be female if accompanied by a calf; mother–calf pairs were obvious, even when other adults were nearby.

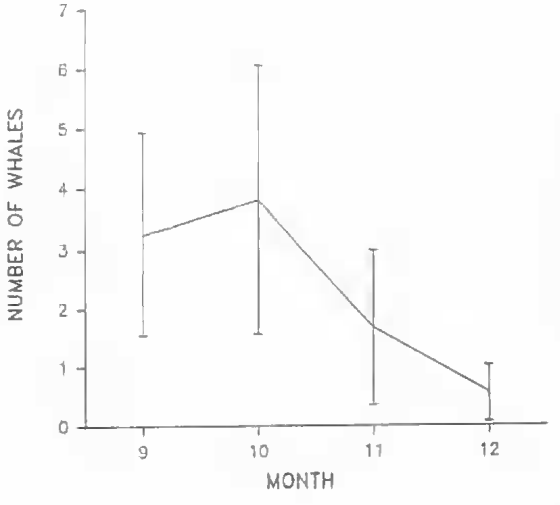

FIG. 11. Humpback whales (adults + calves) per daily sighting hour; southern migration, Perth, September-December, 1989 (mean ± SD).

RESULTS

MONTH	DAYS	CRUISES	PODS	ADULTS	CALVES	0 PODS	REPEAT PODS
Sept	6	7	21	65	2	-	3
Oct	21	34	77	265	13	3	11
Nov.	14	19	25	48	20	5	1
Dec	3	3	2	2	2	1	1
Total	44	63	125	380	37	9	16

TABLE 8. Monthly data collected during whale watching cruises.

MONTH	DAYS	CRUISES	WHALES	MEAN HR/CRUISE	WHALES/HR
Sept	6	7	67	3.54	3.24
Oct	21	34	278	3.28	3.82
Nov	14	19	68	3.20	1.67
Dec	3	3	4	2.36	0.55

TABLE 9. Summary of cruise searchtime, number of whales and daily sighting rate.

An ANOVA was performed on the transformed data (log10) to test differences between months for whales/cruise hour. A significant difference was noted ($F=5.32$, $df=43$, $P=.0035$), and tests (Tukey, Scheffe, SNK) between monthly means indicate that December is different from the remaining months. Removing December also resulted in a significant difference for November ($P=.0092$) from Sept–Oct.

DISCUSSION

No comparative data on humpback whale numbers in the near shore waters off Perth are available; estimated population size is more than 2000. It may be that a significant proportion of the population migrate south close to the coast, using the large bays as resting areas. To what extent and duration these bays are used remains

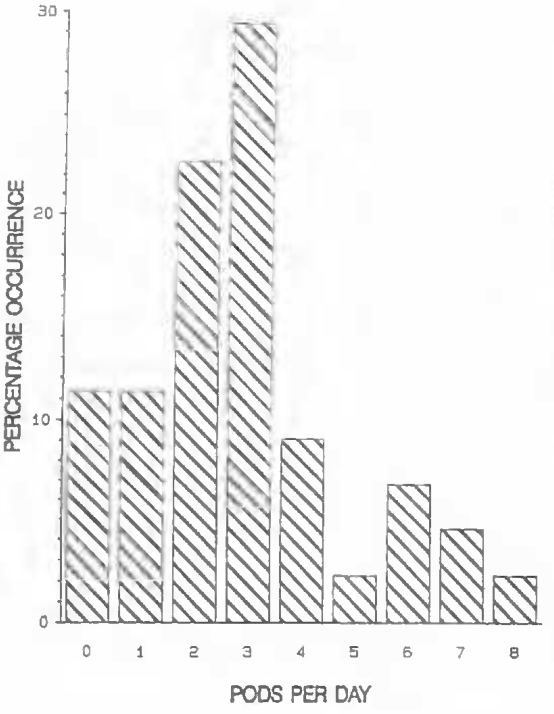

FIG.12. Pods of humpback whales observed per day during the cruises; southern migration, Perth, 1989.

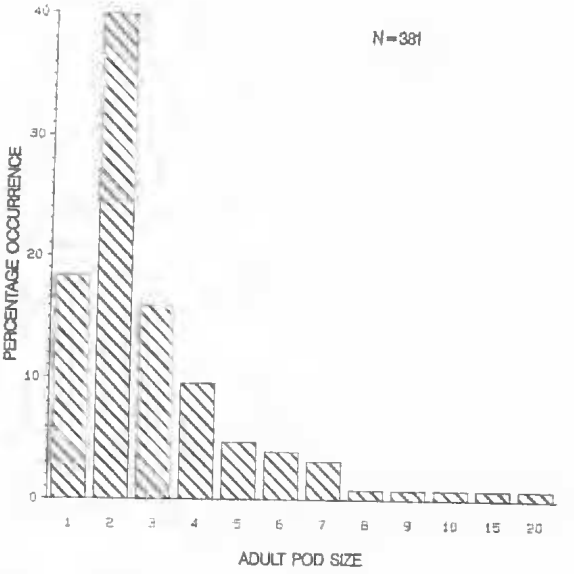

FIG. 13. Frequency of pod sizes observed during the southern migration, Perth, 1989.

to be determined. The photo-id work in 1989 indicates residence times of 4–7 days off Perth.

The distribution of whales over the gridded area suggests that they limit their approach to the coast to depths greater than 20m. Concentration of sightings in the southern region of the study area reflects cruise paths. A series of aerial survey flights over the area would provide a more accurate estimation of their distribution and give some indication of the proportion of whales which pass at a greater distance from the coast and are not seen by the cruise vessels. The effect of the warm, southward flowing Leeuwin current along the Western Australian coast on the spatial distribution of these animals may have to be considered. The number of adults decrease from October. Since the cruises did not commence until late September the initial rise in numbers was missed, and may follow a normal disribution curve, similar to that observed in Queensland from shore (Bryden et al., 1987).

The number of calves increased in November, as previously noted (Chittleborough, 1965). This earlier work by Chittleborough also indi-

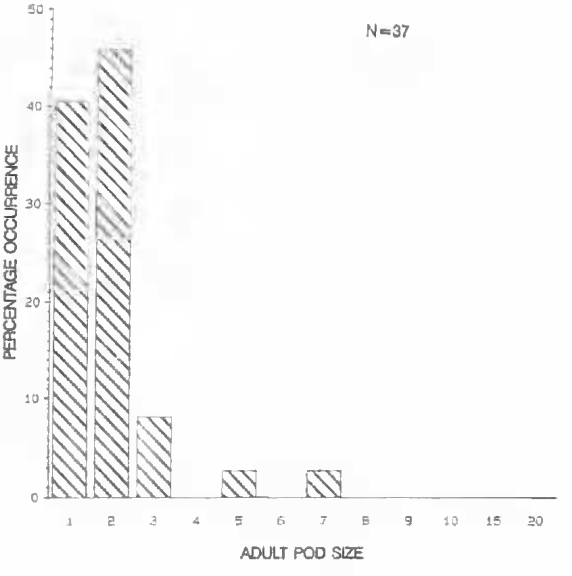

FIG. 14. Frequency of calves with different adult pod sizes observed during the southern migration, Perth, 1989.

cated that the southern migration had passed the Australian mainland by the end of October with a few stragglers remaining in November and December. The numbers of whales seen off Perth in 1989 during November and December were fewer than in October, but still accounted for 17% of observations. Some were also reported in Geographe Bay, south of Perth in November and December; they may be part of the migration which pass close to Perth. Further observations will be necessary to determine if there has been a real change in migratory behaviour compared with that observed by Chittleborough (1965). It is likely that the apparent change in migration over 30 years reflects differences in data collection. On the east Australian coast Paterson and Paterson (1989) recorded a similar migration pattern in 1987 to that recorded by Chittleborough in 1961 but they received reports of some late southward migration during the summer months. However, Stone et al. (1987) have shown differences in the timing of the migration past Bermuda in the North Atlantic Ocean in recent years compared with historical records from the 17–19th centuries.

ACKNOWLEDGEMENTS

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